Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.9, 2015

Evaluating the Effect of Integrated Use of Farm Yard Manure and Urea on Major Soil Chemical Properties in the Low Land Irrigated Areas of North western Tigray, Ethiopia

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Abstract
Soil fertility deterioration is becoming a major constraint for higher crop production in Tigray. The prevailing higher prices of inorganic fertilizer along with low nutrient value and shortage of organic nutrient sources like Farm Yard Manure (FYM) has become a main problem in managing soil fertility problems, especially for resource poor farmers. So, integrated use of organic and inorganic plant nutrient sources help to overcome problems with the sole application and have more rewarding on maintaining better soil fertility. Based on this, a field experiment was conducted to study the effect of integrated use of organic (FYM) and inorganic (Urea) plant nutrient sources on soil fertility improvements in Tselemti wereda, May ani site during the 2012/13 off season time. Organic (FYM) and inorganic (Urea) nutrient sources was integrated in different proportions to supply 60Kgha^{-1} of Nitrogen (N) from both sources at different ratios. The treatment combinations are T1 (control or with no fertilizer), T2 (100%IF), T3 (25% FYM+75%IF), T4 (50%FYM+50IF), T5 (75%FYM+25%IF) & T6 (100%FYM).Phosphorus was applied at a recommended rate in the form of TSP, adjusted on the basis of phosphorus present in the soil and FYM. The experiment was arranged in RCB Design with four replications per treatment. Tomato (variety; Roma VF) was planted in rows. FYM used for the experiment was well decomposed and one year old. Top soil (0-30cm)and FYM were sampled before transplanting tomato seedlings and similarly after harvest soil was sampled and analyzed for its major chemical composition in the laboratory.The results of the experiment showed that the integrated use of FYM and Urea in different proportions significantly increased soil pH, Organic carbon, CEC, ava.P, Total N and ava.K.($p< 0.05$). Comparing fertilized treatments most of the soil parameters were better in treatments where N from FYM source was above 50%.The overall study revealed that a combined application of FYM with Urea at (25:75 and 50:50 ratios) not only significantly improve soil fertility but also increase marketable tomato yield and economic profit. Therefore, it is recommended for tomato producers of Tselemti wereda for profitable tomato yield and sustainable soil fertility.
Keywords: FYM, Inorganic, Integrated, Organic, Soil fertility, Tomato, Urea, Yield, Sole application

1. Introduction

Recent agricultural trends indicate that yield for many crops are not rising as quickly as they did because of declining soil fertility and mismanagement of plant nutrients. So the challenge for agriculture for the future generations will be to meet the world's increasing demand for food while, maintaining and improving soil and environmental quality in a sustainable way (Peter *et al.,* 2006; Reeves, 1997).

According to Balesh (2006), Soil fertility degradation is described as the most important constraint to food security in Africa in general and SSA in particular. Nutrient status is widely constrained by the imbalances caused due to nutrient input and outputs, resulting to negative nutrient balances. The problem with nutrient imbalance is attributed to insufficient use of mineral and organic nutrient sources as inputs relative to nutrient loss as exports, primarily through harvested products, leaching, gaseous losses and soil erosion, resulting in lower crop yields than the potential productivity. It is estimated that an average of 660 kg N ha^{-1}, 75 kg P ha^{-1}, and 450 kg K ha^{-1} has been removed from 200 million hectares of cultivated lands in SSA in the past 30 years (Habtegebrial and Haile, 2009).

Similarly, soil fertility status of Ethiopia is not much different from the situation of SSA region, except higher rates of nutrient depletion and land degradation than most of SSA countries, due to lack of adequate mineral fertilizer input, limited return of organic residues and manure, high biomass removal, erosion, leaching and its dominant high land topography. So, there is an urgent need to improve nutrient management (Habtegebrial and Haile, 2009).

Use of chemical fertilizers is an essential component of conventional agriculture. This approach emphasized the use of external inputs and expensive technologies and often disregarded farmers' knowledge and the resources at their disposal (Ndufa *et al.,* 2005).Excessive amounts of inorganic fertilizers are applied to vegetable crops in order to achieve a higher yield and maximum value of growth. The impact of increased fertilizer use on vegetable production has been large, but ever increasing cost of energy has been an important constraint for increased use of inorganic fertilizer particularly for resource poor farmers (Lay *et al.,* 2002).

Furthermore, ecological and environmental concerns over the increased and indiscriminate use of inorganic fertilizers have done research on the use of organic materials as a source of nutrients very necessary (Muhammad *et al.,* 2003).

Organic plant nutrient sources can serve as potential alternative to mineral fertilizers for improving soil fertility, microbial biomass and crop productivity. So, utilization of locally produced manures by vegetable producers may increase crop yields with less use of chemical fertilizer (Ouda and Mahadeen, 2008).

It is not possible to obtain a higher crop yield by using organic manure alone due to their unavailability in excess amount and they contain a comparatively low quantity of nutrients compared to inorganic fertilizers (Sarker *et al.,* 2011). Therefore, an urgent need to develop a technology which emphasis on the reduced use of purchased chemical fertilizers, the significant saving of scarce cash resources for small farmers, ensures the conservation and efficient use of native soil nutrients and recycling of organic nutrient flows (Vlaming et al.,1997). Hence, integrating the two forms (Organic and inorganic nutrient sources) and using simultaneously has been suggested as the most effective and alternative method of replenishing and maintaining soil fertility in order to achieve better crop yield. In this regard Farm Yard Manure (FYM) integrated with inorganic fertilizers (Urea), is one of the promising techniques for improving soil fertility and increasing tomato productivity (Sadaf and Qasimkhan, 2010).

The use of organic materials in combination with inorganic fertilizers to optimize nutrient availability to plants is a difficult task as organic materials have variable and complex chemical nature. This requires the understanding and knowledge about the chemical composition, particularly the nutrient content and carbon quality of organic materials and its interaction with inorganic nutrient sources. Numerous trials have compared the yields from a given amount of inorganic fertilizer (A), organic material (B) and their combination (A+B), in many situations (A+B) have better soil fertility repletion and produced higher yields than A or B alone

The judicious integrated use of both nutrient sources provides an ideal environmental conditions for the crop, as the organic source improves soil properties and enhance the activity of soil biota, immobilize nutrients and slowly releases them, while the inorganic sources made available nutrients immediately, avoiding nutrient depression periods and hastens the decomposition of organic material (Habtegebrial and Haile, 2009). It has been acknowledged that organic and inorganic fertilizer inputs cannot be substituted entirely by one another and are both required for better and sustainable crop production (Anderson *et al.,* 2002; Place *et al.,* 2003).

The farming system in Tigray is mixed crop –livestock system and farmers are commonly used organic manure especially FYM. FYM is among the important soil amendments to which farmers' access in mixed farming systems. However, availability of FYM in enough amounts is always a concern, but from the literature it is clear that if FYM is integrated with mineral fertilizes', it could be used even for the better and sustained soil fertility. However, no study has been done on the use of integrated fertilization on the soil fertility status so far in the study area. Therefore, the aim of this research was to examine the effect of integrated use of FYM and Urea nutrient sources on soil chemical properties on the off season tomato production, at Tselemti *'woreda'* northern Ethiopia.

2. Materials and Methods

The field experiment was conducted at North Western Zone of Tigray, Tselemti woreda May ani '*kebele'* on farmer fields during the off season of 2012/2013.The experimental site lies at 13^{0}40'N and 38^{0}09'E and at an elevation of 1370 meters above sea level (masl). The mean temperature ranges from a minimum of 15.8 ^{o}C (December) to an average maximum of 35.6^{o}C (May). It is a low altitude area with average 6 years annual rainfall of 1279.75 mm. The average relative humidity, wind speed and daily sun shine hours of the area are 46.2%, 101.7 km day^{-1} and 8.61hrs respectively. Generally the agro-ecological zone of the '*woreda*' is hot to warm-moist lowlands (M1-7) and Tepid to cool-moist mid highlands (M2-5).

The dominant soil types in the study area are Cambisols, Fluvisols, Nitosols and Vertisols. The result of the experimental site soil analysis shows that the textural class of the soil was clay with a particle size distribution of 37% sand, 19% silt and 44% clay and a pH of 5.98. In addition, the soil was slightly acidic with low total nitrogen, low organic carbon and available phosphorus. This type of soil dominates in all irrigation areas of the study '*Woreda*'

Surface soil samples from the depths of (0-30cm) were randomly collected from different points with in the entire experimental field using an auger before planting to form composite samples. The samples were analyzed at Tigray Agricultural Research Institute (TARI) soil laboratory center and Mekelle University to determine the soil chemical and physical properties such as: texture, soil pH, total nitrogen, available phosphorus, available potassium, CEC, and organic carbon. Standard laboratory procedures for analyzing physical and chemical parameters were carried out for the composite surface soil samples. Soil texture was determined by the hydrometric method (Day, 1965; Gee and Bauder, 1986). Organic matter was determined based on the oxidation of organic carbon with acid dichromate medium following the Walkley and Black method as described by Dawis and Freitas (1970). Total nitrogen was analyzed using the Kjeldahl method (Dewis and Freitas, 1970). The available soil phosphorus was determined according to the methods of Olsen and Dean (1965); available potassium using the Morgan method (Morgan, 1941); CEC using the ammonium acetate method and Soil pH was determined in 1:2.5 soils: water ratio using a digital pH meter (Sahelemedhin and Taye, 2000). Composite soil samples of 1kg from three angular points within the plot (0-30 cm) were collected from all the 24 plots after harvest. The same procedure was followed like that of pre planting to analyze the same chemical properties of the soil to determine the effect of applied different treatments in the soil.

Well decomposed and one year old of FYM was used as a source of organic nutrient. The same method as the soil was used for preparation and analysis of the major chemical parameters of the FYM.

The field experiment was laid out in Randomized Complete Block Design (RCBD) with six treatments and four replications. Accordingly, treatments were assigned randomly to the experimental plot within a block.

Tomato is a heavy feeder of plant nutrients especially nitrogen. The nitrogen demand of tomato is depending mainly on the fertility status of the soil, cultivar and the target yields expected. According to Shankara *et al.,* (2005), for 40t/ha of tomato production (bench mark yield planned by BoARD), 120Kg N/ha is required. In order to add the required amount and proper integration of organic and inorganic fertilizers for tomato production, soil test and calibration of nutrients based on soils laboratory result is very important. The following procedures were used for the proper calibration and integration of fertilizers.

A pre- transplanting composite soil (0-30cm) sample was characterized in the laboratory for nitrogen, phosphorus, bulk density and other parameters. Based on the soil laboratory results of nitrogen and bulk density, the total amount of nitrogen/ha in the 0-30cm depth was calculated.

Accordingly, from the total nitrogen present in the soil about half is always be available (dynamic reserve) and the other half does not easily release (inert reserve),similarly only about 4% of the dynamic reserve is directly available for crop production. Through this information the total nitrogen present in the soil is calculated then subtracted from the required amount and identified the gap. In order to fill the gap and supply the recommended amount of nitrogen from both inorganic & FYM sources, laboratory analysis of FYM was also carried out. According to Gordon *et al.,* (2000) the amounts of organic N converted to plant-available forms during the first cropping year after application vary according to both livestock species and manure handling systems, but in general, about 50% of the organic N may become available the year of application and nearly all of the phosphorus in manure is available for plant use the yea of application. Phosphorus was also applied at a recommended rate in the form of superphosphate and adjusted on the basis of phosphorus present in the soil and FYM.

Based on the above procedure there was about 60kg/ha of nitrogen present in the soil. So, only 60Kg N is applied to calibrate the nutrient requirement of the tomato crop. To supply this amount of nitrogen for tomato from the sole application of FYM and Urea 18t and 130Kg is required respectively. The treatments were arranged based on this principle.

Table-1: Treatment details used in the experiment

Treatments	% N from FYM	% N from Urea	Treatment details	Nutrient equivalency from both sources
T_1	0	0	Control	Control
T_2	0	100	No FYM +130Kg/ha Urea	60 Kg N from IF only
T_3	25	75	4.5t/ha FYM+97.5Kg/ha Urea	15Kg N from (FYM)+45Kg N from IF
T_4	50	50	9t/ha FYM +65Kg Urea	30Kg N from (FYM)+30Kg N from IF
T_5	75	25	13.5t/ha FYM +32.5 Kg/ha Urea	45Kg N from (FYM)+15Kg N from IF
T_6	100	0	18t/ha FYM +No IF	60 Kg N from FYM only

All collected data in this study were subjected to one way statistical analysis of variance (ANOVA) following a procedure appropriate to a randomized complete block design and was computed using Gen-Stat 13th edition statistical software. Whenever the treatment was significant, least significance differences (LSD) by Dunken's multiple range comparison was used for mean separation at p=0.05 &p=0.001.The statistical model used for analysis of the data collected from the experimental field is given by:

$$\mathbf{Y_{ijk} = \mu + A_i + B_j + \varepsilon_{ijk}}$$

Where:

$\mathbf{Y_{ijk}}$ = the response variable

μ = Overall mean.

$\mathbf{A_i}$ = Effect of factor A (organic fertilizer),

$\mathbf{B_j}$= Effect of factor B (inorganic fertilizer),

$\boldsymbol{\varepsilon_{ijk}}$ = Treatment error of factor A (organic fertilizer) and factor B (inorganic fertilizer) and replication as block K.

3. Results and Discussion

3.1. Pre-transplanting Surface Soil Laboratory Results

The pre-transplanting composite surface soil sample (0-30 cm) collected from the experimental site was analyzed for some selected physcio-chemical soil properties. The result of the soil analysis showed that the textural class of the soil as clay (37% sand, 19% silt and 44% clay) with a soil pH of 5.98, available phosphorus of 6.54 ppm, CEC of 17.8 meq/100gsoil, organic carbon of 1.65%, and total nitrogen of 0.08% (Table 2). The soils were moderately acidic (5.6-6.1) and has very low total N (less than 0.1%) and poor soil organic carbon (less than 1.7) (Landon, 1991; Defoer *et al.,* 2000). According to these results, clearly justify, the need for the external application of organic or/and inorganic sources based on the base recommendation for the different crops grown in the area. Similarly, the results of the undisturbed soil analysis were used as inputs in determining the frequency and amount of irrigation during the experimental period.

Table -2: Pre-transplanting soil physico- chemical properties (0-30cm)

S/N	Characteristics	Unit	Value
1	Sand	percent	37
2	Silt	percent	19
3	Clay	percent	44
4	Textural Class Name	-	Clay
5	$_{P}$H	-	5.98
6	Organic Carbon	percent	1.65
7	CEC	meq/100gsoil	17.8
8	Total nitrogen	percent	0.08
9	Available phosphorus	ppm	6.54
10	Available potassium	ppm	154.4
11	Bulk density	gcm^{-3}	1.251

3.2. Chemical composition of FYM

The laboratory analysis result indicated that, the FYM were contained 21.55% organic matter 0.67 % total nitrogen, 450 ppm available phosphorous and 1467.24 ppm of available potassium. This result indicates that, the FYM have very high organic matter, total nitrogen and available phosphorus (London, 1991).

Table-3: Chemical characteristics of FYM used in in this study

Manure	PH	OC (%)	OM (%)	TN (%)	Av.p ppm	Av.K ppm	CEC Meq/100g
FYM	7.26	12.52	21.55	0.668	454	1467.24	46.3

3.3. Effects of integrated use Organic and IF on Soil Chemical Properties

The mean square of the treatments of integrated use of organic and inorganic fertilizers on post-harvest soil chemical properties is presented in table 4. The statistical analysis showed that combined application of organic (FYM) and inorganic (Urea) fertilizers showed significant effect on all the soil chemical properties of the experimental area (Table 4).

Table-4: Mean squares for Soil OC, OM, pH, Ava.p, TN, Ava.K and CEC.

Source of variation	Df	OC (%)	OM (%)	pH	TN (%)	Ava..P (ppm)	Ava.K (ppm)	CEC (meq/100g)
Replication	3	0.02	0.06	0.004	0.0003	0.21	5.78	3.54
Treatments	5	0.29**	0.86**	0.061**	0.004**	10.54**	2137.5**	44.79*
Residual	15	0.009	0.028	0.0014	0.0002	0.12	7.37	8.24
Total	23							

OC=OrganicCarbon;OM=OrganicMatter;TN=TotalNitrogen;Ava.p=Availablephosphorus;Ava.K=available potassium; CEC=Cation Exchange Capacity; Df=Degree of freedom;*significant at $p<0.05$,**significant at $p<0.01$;ns=non-significant; ppm=parts per million; %=percentage

As shown from table 1, the initial chemical properties of the soils indicate that they have low nutrient contents. Comparison of fertility status of the soil after cropping showed that a combined application of organic and inorganic fertilizer increased considerably the soil organic carbon content, CEC, available phosphorus and available potassium, total nitrogen and pH indicating that there is improvement of the fertility status of the soil (Table 4). The increase in the levels of soil organic carbon and organic matter might be the contribution of organic manures, due to the ability of increasing soil organic matter content, and the contents of some major nutrients in the soil which are slightly dependable on the level of organic matter (Adeniyan *et al.,* 2011). Organic matter shows a greater capacity to retain nutrients in forms that can easily be taken up by plants over a longer period of time and have a longer residual effect of organic manures when applied to the soil (ibid)

3.3.1. P^H

It is an important indication of the chemical status of the soil. Soil pH may provide a useful index of potential nutrient holding capacity and fertility condition of soils. The results of the mean squares analysis of the effects of integrated use of organic and inorganic nutrient sources on the major soil chemical properties are shown in (Table 4). These results indicates that all the treatments increased the soil pH significantly (P<0.01) over the control treatments. High pH (6.14) was observed in (T5) where 75% Nitrogen(N) was applied from organic (FYM) and 25% from inorganic (Urea) sources followed by (T4) where 50% N from FYM and 50% from Urea. Soil pH increased in all treatments except in the control and only Urea fertilized treatments, compared to the pre sowing result. Plots receiving from a mixed application of FYM and Urea at (25:75, 50:50 and 75:25) ratios significantly increase the P^H of soil as compared with plots receiving Urea (100%) alone and the control (non-fertilized) treatments. plots receiving 100%N from FYM was recorded lower pH than plots receiving from a combination of (75: 25% and 50:50).

The results indicated that under the given experimental conditions, the combined application of FYM and urea significantly improved pH of the soil. So, tomatoes do the best with a PH of 6.0-6.8, therefore application of combined FYM and Urea at a ratio of 50:50(T4) and 75:25(T5) improved the soil pH from 5.98 to 6.1 and 6.14 respectively which is best range for tomato growth and increase the availability of most other nutrients in this P^H range of soils. Reducing the level of N from inorganic (Urea) source to 25 % with the remaining from FYM better improves soil pH than the rest treatments (Table 4). In this concern Adeniyan *et al*., (2011), reported similar results and explained that combined use of organic and inorganic manures could serve as good amendment materials in ameliorating acid soils.

3.3.2. Organic carbon (%)

Sole and a combined application of organic and inorganic N sources had a highly significant effect (p<0.01) on the organic carbon content of the sampled soil compared with the control treatments. Sole (100%) FYM fertilized plots were superior over the mixed and only inorganic fertilized plots. Similarly combined fertilized plots perform better than the sole urea treated plots in soil organic carbon. The highest organic carbon content (2.54%) was recorded in plots fertilized with 100%N from FYM sources. Organic carbon of the soils was increased from 2.21% to 2.54% as the ratio of FYM increases from 25% to 100%. Combined application of FYM with urea even at a small ratio of FYM improves the soil organic carbon better than only Urea fertilized plots. Likewise plots fertilized with only 100% FYM had 45.97% higher organic carbon content over the control.

The increase in soil organic carbon of sole FYM and mixed fertilized plots might be due the added FYM, because all organic manures especially FYM contains a significant amount of organic carbon. Similar results have also been reported by Abay *et al.* (2011) who reported an increase in soil organic carbon after harvest of 'teff', which might be attributed to decays of weeds and roots of the test crop and/or reduction of organic matter decomposition rate during the growing period of the crop. The results indicate that continuous application of organic manure could enhance organic matter accumulation in the soil.

3.3.3. Available Phosphorus

The results provided in table 5 show that all the treatments had significantly improved (P<0.01) the available P status over the control. It also indicated that the combined application of FYM and Urea at a ratio of (50:50 and 75:25) significantly improved available phosphorus compared with Urea and FYM alone. Higher and significant increase of available phosphorus (67.13%) was recorded in plots receiving nitrogen from FYM and Urea in 75:25 combinations followed by plots received in 50:50 combinations (Table 5). The probable reason could be attributed to the influence of organic manure which reduced the P-sorption capacity of the soil and enhance the available Phosphorus in the soil by forming complex with ions of Calcium, Magnesium and Aluminum.

The lowest available phosphorus was obtained in control plots may be due to fixation of phosphorus. As the application rate of FYM increased from 25% N (T3) to 75% N (T5), the available phosphorus also significantly increased from 7.78 ppm to 11.8ppm (Table 5). The available phosphorus content was increased considerably in all fertilized treatments/plots as compared to the pre –planting results. The results also indicated that integrated application of organic and inorganic plant nutrient sources in irrigated tomato had added higher amount of phosphorus to the soil than the only Urea fertilized treatments. The probable reason why available soil P was higher in 75:25(T5) combinations may be due the added inorganic (Urea) fertilizer that hastens the mineralization and increase the slow release of P from FYM by activating the soil biological activities. The results agree with the findings of Aspasia *et al., (*2010) reported that combined organic/inorganic fertilization improves the organic carbon status and available NPK and S in soil, sustaining soil health. Similarly Indrani *et al.,* (2008) also reported that increase of available phosphorus might be due to the decomposition of organic matter accompanied by the release of appreciable quantities of carbon-di-oxide, as carbon-di-oxide production plays an important role in increasing phosphate availability.

3.3.4. Available Potassium

The analysis results (Table 5) show that all fertilized treatments significantly (P<0.01) increase the available potassium content compared with the control treatments. The available potassium content of the soil was highest

(186.4ppm) in plots fertilized with 75% N from FYM and 25% from inorganic (urea). The next highest value (181.2ppm) for available K was obtained from treatments receiving 50% N each from FYM and urea. Lower values were noticed in control, with 121.7ppm (Table 5).These results suggested that, the integrated use of inorganic(urea) and FYM improves better than the use of urea or FYM alone in terms of improving available potassium despite the fact that the level of applied N was same either alone from urea, FYM or combinations of both. The increase in soil available K in the combined use of organic and inorganic nutrient sources is also important for the improvement of fruit quality by reducing cracking and improved the size of the fruit.Improvement in the soil properties with application of organic manure might be a result of buildup in the organic carbon, solublization of different organic nitrogenous compounds into simple and available form, acidifying action of FYM on applied P at the time of decomposition making more P available, and reduction of K fixation (Seyed, 1998).

3.3.5. Cation Exchange Capacity

The soil analysis after harvest shows that the cation exchange capacity of soil was significantly ($P<0.05$) greater in plots that fertilized with FYM alone (N at 100%) and the combined application of FYM and Urea at 75:25(T5) ratios than the inorganic (Urea) application alone and the control treatment (Table 5). The maximum CEC content of (27.38meq/100g soil was obtained in plots receiving 100% N from FYM only(T6) and a combination of FYM and Urea at (T5)75:25 ratios followed by 25.45meq/100g in plots receiving 50% N from FYM and 50% from urea (T4). It was also observed that application of organic manures to the soil increased considerably the soil organic C, total N, available P, available K and CEC compared to using the inorganic fertilizers and control (Table 5). The increase in CEC of the soil in the experimental field especially in combined and sole FYM fertilized plots was may be due to the added FYM that increases the soil organic matter which in turn, increase the negative charges and be getting higher CEC. Indrani *et al.,* (2008) reported similar results in which CEC, available P, available K and organic carbon were significantly increased with the integrated use of organic manure in conjunction with inorganic fertilizers.

3.3.6. Total Nitrogen (TN)

The one way ANOVA of soil analysis after harvest showed that Total Nitrogen (TN) content of the soil was significantly greater in the N fertilized than in the control treatments (Table 5). The maximum total nitrogen content of 0.165% was obtained in plots receiving 100% N from FYM followed by 0.155% in plots receiving nitrogen in 75:25(T5) combinations; in both cases the values were significantly greater from other N fertilized treatments. Mixed use of FYM and Urea especially at a higher ratio of FYM improves total nitrogen greater than Urea fertilized plots. This is may be due to the less mobility nature of nitrogen present in FYM than inorganic fertilizers, which accounts greater N in soils after harvest. This result agrees with the findings of Zhao *et al., (*2009) which indicated that FYM combined with chemical fertilizer management resulted in higher increase in soil organic matter, available nitrogen and available phosphorus. Combining organics with inorganic fertilizer increase synchrony and reduce losses by converting inorganic N into organic forms. This increase in total N by the organic manure (FYM) might be due to the direct addition of N through organic manure added to the soil because the low recovery efficiency of N is associated with its loss by leaching, denitrification, volatilization and soil erosion Aspasia *et al. (*2010).

Table-5**:** Influence of combined application of organic and IF fertilizers on soil properties

Treatments	**Treatment combination**		**OC (%)**	**pH**	**TN (%)**	**Ava.P (ppm)**	**Ava.K (ppm)**	**CEC (meq/100**
	%N from FYM	**% N From Urea**						
T_1	**0**	**0**	**1.74^{d}**	**5.80^{d}**	**0.09^{c}**	**7.06^{e}**	**121.7^{e}**	**20.9^{b}**
T_2	**0**	**100**	**1.99^{c}**	**5.93^{c}**	**0.11^{c}**	**$8.34c^{d}$**	**155.4^{d}**	**22.75^{b}**
T_3	**25**	**75**	**2.21^{b}**	**6.01^{b}**	**0.097^{c}**	**7.87^{d}**	**158.3^{d}**	**22.45^{b}**
T_4	**50**	**50**	**2.23^{b}**	**6.10^{a}**	**0.13^{b}**	**9.03^{b}**	**181.2^{b}**	**25.45^{ab}**
T_5	**75**	**25**	**2.24^{b}**	**6.14^{a}**	**0.16^{a}**	**11.80^{a}**	**186.4^{a}**	**27.38^{a}**
T_6	**100**	**0**	**2.54^{a}**	**6.03^{b}**	**0.165^{a}**	**8.83^{c}**	**167.5^{c}**	**27.38^{a}**
CV (%)			**4.5**	**0.6**	**10.2**	**3.9**	**1.7**	**11.6**
SEM(±)			**0.049**	**0.019**	**0.006**	**0.173**	**1.358**	**1.435**
LSD(0.05)			**0.15**	**0.06**	**0.018**	**0.5**	**4.1**	**4.32**

Means with different alphabets in the same column indicate significant difference($p<0.05$

3.4.Correlation of Selected Soil Chemical Properties

The simple partial correlation coefficient analysis result of soils revealed that soil fertility parameters after harvest showed a positive and highly significant ($P<0.01$) correlation with the major soil fertility measurements such as Organic carbon, total nitrogen, available Phosphorus, CEC etc. Organic carbon was positively and highly significantly correlated with P^{H} (r=0.69**), Total nitrogen(r=0.75**), Available potassium (r=0.69**), available phosphorus (r=0.44**) and CEC (r=0.47*) (Table 7). Similarly total nitrogen was also positively and strongly correlated with organic carbon (r=0.75**), available potassium (r=0.68**), available phosphorus (r=0.69**) and soil pH(r=0.7**). This might be due to complementary effect of organic and inorganic fertilizers that increase nutrient synchrony and reduces losses by converting inorganic to organic forms which optimum use of each type of fertilizers for crop growth (Aspasia *et al.,* 2010).

Table-6: Simple partial correlation between major soil fertility parameters

	pH	OC (%)	TN (%)	Ava.K ppm	Ava.P PPM	CEC meq/100
pH	1.000	0.69**	0.7**	0.94**	0.77**	0.66**
OC (%)		1.000	0.75**	0.69**	0.44*	0.47*
TN (%)			1.000	0.68**	0.69**	0.67**
Ava.K (ppm)				1.000	0.79**	0.67**
Ava.P (ppm)					1.000	0.7**
CEC(meq/100g)						1.000

Conclusions

Integrated use of organic (FYM) along with inorganic (Urea) fertilizers performed better than the use of FYM or Urea alone in terms of improving major soil chemical properties, despite that the level of applied nitrogen (N) was same either from alone or combination of both and the interest of farmers toward the use of combined nutrient source is increasing. The statistical result of this investigation showed that the combined use of FYM and inorganic fertilizers significantly affect (increase) all most all of the chemical soil properties in the study site. Soil properties such as organic carbon, soil pH, total nitrogen, available phosphorus etc. were considerably improved. The result also showed that in plots fertilized with 50% N from FYM and above increase in all the soil quality parameters. The combination of FYM and inorganic (Urea) fertilizers at 75:25 or 50:50 ratio increased organic carbon, soil pH, available phosphorus, available potassium and cation exchange capacity better than the application of either FYM or Urea alone. From this it can be concluded that the integration of FYM with inorganic fertilizer is the best approach for soil fertility management and improving tomato productivity

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